Installing Instrumentation on Insulated Bearings

Observations and Suggestions Based on a Review of Installations

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Generators and motors have at least one *insulated* bearing, usually at the non-drive (exciter) end. In some cases both the drive- and the non-drive-end bearings are insulated.

In most cases, the bearing pedestal or housing is mounted on phenolic sheets, and the holddown bolts have phenolic sleeves and washers. Examples of this method are shown (colored red) in Figure 2. On larger generators, the bearing housing is attached to an end plate. In this instance, the insulation is placed between the bearing housing and the end plate.

Sometimes, it will be difficult to visually detect any isolation, as it may well be an integral, internal part of the bearing assembly. Spherical bearing alignment pads are sometimes installed with phenolic insulation (colored red) between them and the bearing in Figure 1. In bearing blocks supplied by some bearing OEMs, a layer of PTFE insulation is found on the bearing housing spherical location or seating.

Frequently Asked Questions

Q Why does the motor or generator have insulated bearings?

A Large rotating motors and generators generate an electrostatic discharge (ESD) current. [Editor's Note: See *Electrostatic Discharge in Rotating Machinery* on page 23.] The circuit path would consist of the rotor, drive-end bearing, frame and non-drive-end bearing. This current typically has high voltage and low amperage, and insulating a bearing will open the circuit and prevent current flow.

Q What effect does current have on the bearing?

A The rotor builds up a charge, which should be dissipated through the earth brush. When this brush is inoperative, or if the bearing is not properly insulated, there is a risk of this charge

End view of typical generator with insulated alignment pads

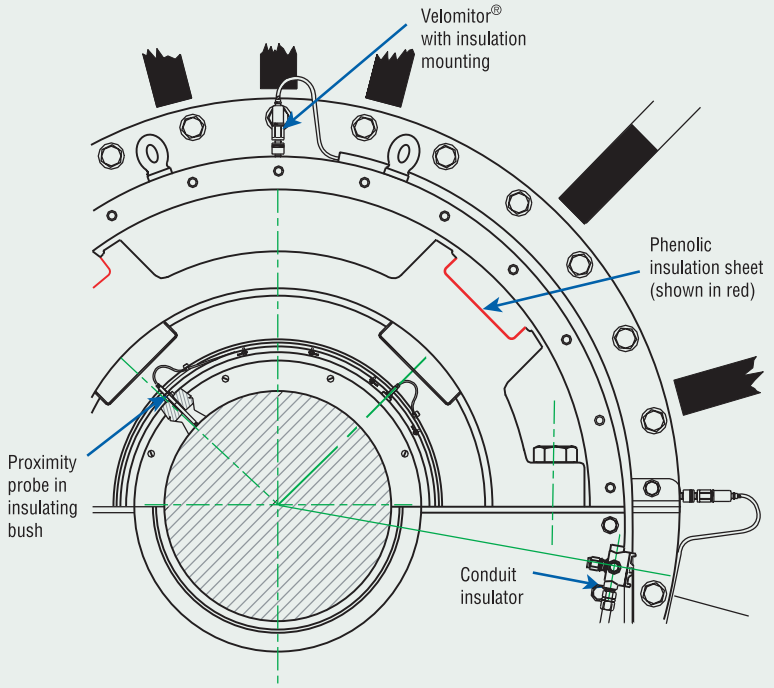

Figure 1.

being dissipated to ground via the bearing Babbitt. When this happens, electric arcing occurs between the journal and the Babbitt, causing a "knife cut" mark in the Babbitt. When the charge is dissipated, the arc collapses, which limits its duration and, hence, the length of the mark.
On smaller units having rolling element bearings, this dissipation causes markings on the inner and outer races – they appear as axial lines of varying thickness and spacing – somewhat similar to bar codes.

Q These marks on the bearing are not very deep – do they matter?

A Where these markings occur, they will concentrate stress. If the machine is in distress, for whatever reason, a change in bearing load or attitude may result in the Babbitt surface breaking up; the resulting failure can cause a costly loss of operation. Similarly, the marking on the raceways of the rolling element bearings will lead to premature failure.

Q Doesn't the lube oil insulate the rotor?

A Clean oil is a good insulator, but dirty oil is a conductor. Thus, don't assume that your lube oil will always act as an insulator. In addition, if the voltage is high enough, it will break through the oil film, clean or not, where it is thinnest.

Q Are there methods of preventing oil breakdown?

A Yes. Since the drive-end bearing is grounded to the frame, an earthing brush is fitted on the bearing housing, contacting the shaft. This will short-circuit the arc and prevent damage to the bearing.

Q How can I identify if there is an earthing brush?

A In some cases, it is a carbon block backed with a spring; in other cases, it may be simply a section of copper grounding braid or copper brush running on the shaft.

Q How does instrumentation installed on insulated bearings affect the ground?

A First, the instrumentation has the potential to cause a fugitive ground path for the current through the bearing, thus causing possible damage to and failure of the bearing. Second, the instrumentation system will be exposed to bursts of noise that could result in nuisance alarms and possible false trips, at the minimum. This will lead to loss of confidence in the monitoring system.

Q So, *how* do we avoid grounding problems?

A Ensure that the proximity probes or case-mounted transducers are *not* providing a path from the insulated bearing to ground. Test each transducer cable to make sure it is not grounded. Also, check the conduit; the flexible conduit will ground the bearing to the Proximitor® housing. Be aware that the armoured cables are not totally insulated; if there is damage, the cable could be shorting the insulated bearing to ground.

Q OK, but *how* can I install a Velomitor® Sensor to meet the EMC requirements and *still* keep the bearing insulated?

A The published EMC Applications Note [part number AN073] requires that the Velomitor® case be grounded to the machine case. If the machine case is insulated, it may not meet the installation criteria.
The solution is to use a UK0471 Isolation Mounting (Figure 2). This product isolates the Velomitor Sensor from the bearing, by means of hard epoxy glass fibre isolation bonded between thread adapters (316 Stainless Steel) – giving many options for both transducer and mounting threads. The mounting also provides an earth tag that allows the insulated side of the mounting to be connected to the Proximitor® housing earth. This EMC earthing cable should be 6 to 4 AWG, and run with the Velomitor® Interconnection Cable – both being attached to the Insulated Bearing with Insulated Cable Clips.

Q Does this Isolation Mounting affect the vibration signal?

A Good point – the inclusion of any isolation material into the vibration signal path will reduce the high frequency response of the transducer. For this reason, we recommend that the use of the Isolation Mounting is limited to applications where meaningful data will be below 1500 Hz. [Editor's Note: A response curve is available on the transducer's Data Sheet.]
This will not be a problem with large 50/60Hz Generators, but where rolling element bearings are being monitored, the ball/roller passing frequency should be determined.

Velomitor® isolation mounting on a typical exciter bearing pedestal

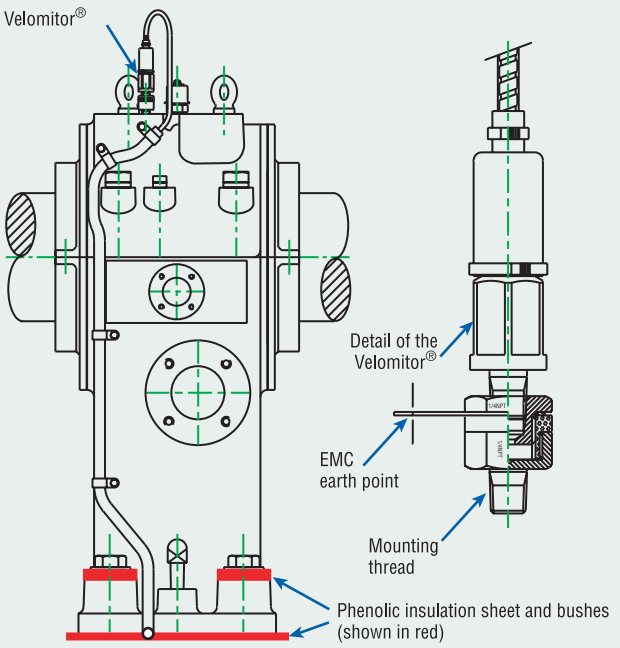

Figure 2.

Q In some installations the probes are installed in a phenolic mounting bracket or isolation bushes – *why?*

A The standard proximity probes may not provide sufficient insulation for the voltages found on generators. It is an additional secure practice that makes a better installation.

Q If bearing temperature probes are installed as part of a retrofit project, will these need to be insulated as well?

A The use of mineral-insulated thermocouples or RTDs could ground the bearing, especially on those types of bearings having insulated spherical location or phenolic insulation (as in Figure 1). The instrument selected should not have a bare metallic case, which will ground the bearing shell to the housing. The temperature element should have an insulated oversleeve, or flexible leads that isolate the element from the bearing housing. The larger diameter elements are available with isolation tests up to 1000 V_{rms}.

Q If the thermocouple must be insulated, does this imply that a grounded-tip thermocouple should *not* be used in insulated bearings?

A Correct. This is an additional restriction. These thermocouples are intended for rapid response, so they are often specified. However, if they were to be installed in an insulated bearing, they would ground the bearing via the monitoring system – which is not acceptable.

Q Any other special precautions to observe?

A If the earth brush or pedestal ground strap is faulty, it is possible to receive an electrical shock due to the ESD voltage. Use extreme caution and make certain that all accumulated charge is fully dissipated on a stopped machine, or that the voltage mitigation system is functioning properly on a running machine.

Summary

If you are working on generators and motors, ensure that the monitoring system is *not* the ground path for insulated bearings – check grounding, and insulate as appropriate.

There are numerous considerations when installing instrumentation on large generators and motors. In many cases, customers will prefer that Bently Nevada perform the installation. As this article illustrates, we have extensive experience, allowing us to manage the many details inherent in a retrofit project. In those situations where you wish to perform the installation yourself, Bently Nevada can provide engineering consultation services to help your installation go smoothly.